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EFFECTS OF HORSE GRAZING IN SPRING ON SURVIVAL, RECRUITMENT, AND WINTER INJURY DAMAGE OF SHRUBS

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ABSTRACT.—The use of domestic grazers to shift the growth advantage toward shrubs is a commonly applied tool on winter ranges managed primarily for big game. Results from horses grazing in spring indicated grazing also benefits shrub survival, seedling recruitment, and reduced winter injury damage on some species of shrubs.

Key words: winter range, range management, mule deer, horses, shrubs, browse, Utah, revegetation, mountain big sagebrush, Douglas rabbitbrush, true mountain mahogany.

On winter ranges managed primarily for big game, the management alternative often selected to maintain the desired mixture of shrubs and understory herbage is grazing by livestock in spring. Numerous studies have reported the benefits of spring livestock grazing to maintain and improve stands of shrubs on winter ranges (Christensen and Johnson 1964, Smith and Doell 1968, Jensen et al. 1972, Hull and Hull 1974, Reiner and Urness 1982, Austin et al. 1994, and others). However, information is limited concerning shrub responses to the effects of livestock grazing with respect to (1) survival of individual mature plants, (2) seedling recruitment, and (3) winter injury damage. In this study the responses of shrubs to domestic horse grazing treatments in spring are reported for *Artemisia tridentata* var. *vaseyana* [Rydb.] Beetle (mountain big sagebrush), *Chrysothamnus viscidiflorus* [Hook.] Nutt. (Douglas rabbitbrush), and *Cercocarpus montanus* Raf. (true mountain mahogany).

METHODS

The study site, located on the foothills east of Logan, UT, 41°46′ N latitude, 111°47′ W longitude, at 1600 m elevation, contained three 50 × 50-m adjoining paddocks. Within each paddock the three browse species were hand-planted from transplants in spring 1983 in 5 × 5 clusters of 25 plants, with 1 m between plant centers. Seven clusters were planted in each paddock, with each cluster separated by a minimum of 20 m. Before planting, all vegetation was removed by root plowing; for two growing seasons following planting, all seedlings were removed by hand and rototiller weeding. Between 1983 and 1987 the three paddocks received equal use by mule deer (*Odocoileus hemionus*) in winter and no livestock grazing. A detailed description of the site is found in Olsen-Rutz and Urness (1987).

This study was conducted during the six growing seasons between spring 1987 and fall 1992. In spring 1987 all shrub seedlings that had become established from seeds were removed from each paddock by hand pulling to minimize soil disturbance. The number of surviving, previously transplanted shrubs within each cluster was counted.

Paddocks were randomly assigned a grazing treatment by horses as heavy, moderate, or protected. Three to seven horses were used, depending upon herbage production, to obtain utilization levels of 35–50% and 65–80% for moderate and heavy treatments, respectively. Horses were selected as grazers because of their high foraging selectivity for grasses and avoidance of shrubs, and the managerial opportunity to manipulate the herbaceous understory to improve shrub growing conditions (Reiner and Urness 1982). Paddocks were grazed yearly between 1 May and 30 June 1987–1991. In 1992 all paddocks were rested from grazing. In the moderately and heavily grazed paddocks, herbage production, comprised almost entirely of annual grasses, and percent utilization were determined from four paired 1-m^2 basketed and unprotected plots, randomly placed in spaces between clusters. Baskets were constructed from 1.2-m-high netting wire supported

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by steel fence posts. Plots were reestablished and relocated yearly before grazing.

In fall 1992 all surviving shrubs were counted by cluster, all seedlings within 10 m of each cluster were counted, and percent winter injury damage was visually estimated. Winter injury was defined as the amount of dead stems and twigs as a percentage of total dead plus live stems and twigs. Damage was estimated at five-unit increments from 0 to 95%.

Because we were not able to replicate the three paddocks established for the previous study, we considered clusters as experimental units. We agree with Hurlbert (1984), who described this experimental design as "simple pseudoreplication," but because of constraints of time, space, and costs, this design was the only option. Consequently, we recognize that differences between treatments could be caused by inherent differences between paddocks, but argue that potential spatial error is low due to adjoining paddocks, identical use during the three years preceding our experiment, simple grazing treatments applied, and lack of differences in the number of surviving seedlings among paddocks for each species ($P > .10$) at the beginning of the experiment.

T tests of the means were used to determine differences between grazed and protected plots within and among paddocks. For plant survival a split-plot design using repeated measures (1987 and 1992 data) analysis of variance determined treatment and year effects. One-way ANOVAs assessed differences among treatments for species within years. For seedling recruitment, because all seedlings were removed in 1987, one-way ANOVAs were used for species within years. For winter injury damage, differences between treatments were analyzed using chi-square tests. A significance level of $P < .10$ was used for all tests.

RESULTS AND DISCUSSION

Horse Grazing

Horse use reduced herbage at the end of the grazing period during all years in both the moderately and heavily grazed treatments ($P < .10$), except in 1987 when neither treatment was different from protected plots. Mean herbage utilization during all years was 46% in the moderately grazed treatment and 71% in the heavily grazed treatment. Following grazing, remaining herbage was different between the moderately and heavily grazed treatments during all years except 1987. Herbage production in protected plots was not different from the moderately and heavily grazed treatments during the first three years. However, the heavily grazed treatment had lower production during the last two years, suggesting that heavy grazing by horses reduced production of herbage.

Shrub Survival

Horse grazing increased survival of *Artemisia* ($P = .01$) and *Cercocarpus* ($P = .10$) but had no effect on *Chrysothamnus* (Table 1). All three species declined in numbers between 1987 and 1992 ($P = .001$).

In 1987 the number of surviving plants among treatments for *Artemisia*, *Chrysothamnus*, and *Cercocarpus* was not different (Table 1). However, in 1992 the number of surviving *Artemisia* plants among treatments was different ($P = .005$). The protected treatment had lower survival than both the moderately and heavily grazed treatments ($P = .001$), but the moderately and heavily grazed treatments were not different. Similarly, for *Cercocarpus* the number of surviving plants among treatments was different ($P = .03$). The protected treatment had lower survival than both the heavily ($P = .005$) and moderately ($P = .10$) grazed treatments, but the moderately and heavily grazed treatments were not different. For *Chrysothamnus*, no differences were found.

Seedling Recruitment

For *Artemisia*, seedling recruitment was significantly different among treatments ($P = .08$). The heavily grazed treatment had more seedlings than the protected and moderately grazed treatments ($P = .05$). No differences among treatments were found for *Chrysothamnus*, and no seedlings were counted for *Cercocarpus* (Table 1).

Although the low numbers of seedlings counted in this study require interpretive caution, results are consistent with other studies in which livestock grazing was reported to increase shrub density (Stewart 1941, Christensen and Johnson 1964, Hull and Hull 1974). Furthermore, the results from this study, that horse grazing in spring resulted in higher survival of mature plants and increased seedling establishment for several species of shrubs, are consistent with reports of increased production of shrubs following livestock grazing

TABLE 1. Plant survival (total number/paddock), seedling recruitment (total number/paddock), and winter injury damage (mean % per shrub) of *Artemisia tridentata* (ARTR), *Chrysothamnus viscidiflorus* (CHVI), and *Cercocarpus montanus* (CEMO), as affected by heavy (H), moderate (M), and protected (P) horse grazing treatments[1].

Species	Treatment	Year	
		1987	1992
Shrub survival		Number/paddock	
ARTR	H	119	91[a]
	M	128	93[a]
	P	120	42[b]
CHVI	H	125	110
	M	86	78
	P	106	101
CEMO	H	164	158[a]
	M	161	140[ab]
	P	168	119[b]
Seedling recruitment[2]		Number/paddock	
ARTR	H	—	18[a]
	M	—	5[b]
	P	—	5[b]
CHVI	H	—	2
	M	—	2
	P	—	3
Winter injury damage[3]		Mean % per shrub	
CEMO	H	—	11[a]
	M	—	24[b]
	P	—	41[c]

[1]Data with different superscripted, lowercase letters within year and species were different at $P < .05$.
[2]No seedlings of CEMO were found.
[3]No winter injury damage on ARTR or CHVI was found.

with horses (Reiner and Urness 1982, Austin et al. 1994), sheep (Jensen et al. 1972), cattle (Smith and Doell 1968), or goats (Riggs and Urness 1989).

Winter Injury

Winter injury was not found on either *Artemisia* or *Chrysothamnus* (Table 1). For *Cercocarpus,* winter injury among treatments was different ($P = .001$), with highest damage occurring on the protected treatment, medium on the moderately grazed treatment, and lowest damage on the heavily grazed treatment. All treatments were different from each other ($P = .001$).

Winter injury has been reported for many shrub species, including *Cercocarpus* (Nelson and Tiernan 1983). However, only one known report compared winter injury to grazing. Contrary to our results, Jensen and Urness (1979) compared heavy (70%) and moderate (35%) levels of grazing of grasses and forbs by sheep and reported that injury to *Purshia tridentata* (antelope bitterbrush) was independent of grazing intensity or time of use.

SUMMARY

Our results support the use of grazing by horses of herbaceous understory in spring to maintain and improve stands of browse for winter use by big game. Herbage production was reduced by heavy grazing, survival of mature plants of *Artemisia* and *Cercocarpus* was increased, recruitment of *Artemisia* was increased, and winter injury to *Cercocarpus* was decreased. No negative effects on shrubs from grazing by horses were found.

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LITERATURE CITED

AUSTIN, D. D., P. J. URNESS, AND S. L. DURHAM. 1994. Impacts of mule deer and horse grazing on transplanted shrubs for revegetation. Journal of Range Management 47: 8–11.

CHRISTENSEN, E. M., AND H. B. JOHNSON. 1964. Presettlement vegetation and vegetational change in three valleys in central Utah. Brigham Young University Science Bulletin, Biological Series IV(4): 1–15.

HULL, A. C., JR., AND M. K. HULL. 1974. Presettlement vegetation of Caebe Valley, Utah and Idaho. Journal of Range Management 27: 27–29.

HURLBERT, S. H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54: 187–211.

JENSEN, C. H., A. D. SMITH, AND G. W. SCOTTER. 1972. Guidelines for grazing sheep on rangelands used by big game in winter. Journal of Range Management 25: 346–352.

JENSEN, C. H., AND P. J. URNESS. 1979. Winter cold damage to bitterbrush related to spring sheep grazing. Journal of Range Management 32: 214–216.

NELSON, D. L., AND C. F. TIERNAN. 1983. Winter injury of sagebrush and other wildland shrubs in the western United States. USDA Intermountain Forest and Range Experiment Station Research Paper INT-314.

OLSEN-RUTZ, K. M., AND P. J. URNESS. 1987. Comparability of foraging behavior and diet selection of tractable and wild mule deer. Utah Division of Wildlife Resources Publication No. 88-3.

REINER, R. J., AND P. J. URNESS. 1982. Effects of grazing horses managed as manipulators of big game winter range. Journal of Range Management 35: 567–571.

RIGGS, R. A., AND P. J. URNESS. 1989. Effects of goat browsing on Gambel oak communities in northern Utah. Journal of Range Management 42: 354–360.

SMITH, A. D., AND D. DOELL. 1968. Guides to allocating forage between cattle and big game on winter range. Utah Division of Fish and Game Publication No. 68-11.

STEWART, G. 1941. Historic records bearing on agriculture and grazing ecology in Utah. Ecology 39: 362–375.

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